



When is an NTU not an NTU? **New Reporting Procedures by USGS** **and ASTM Address Turbidity Data** **Comparability and Storage Issues**

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Take Home Messages

**There is no such thing as
“The Correct Turbidity”!**

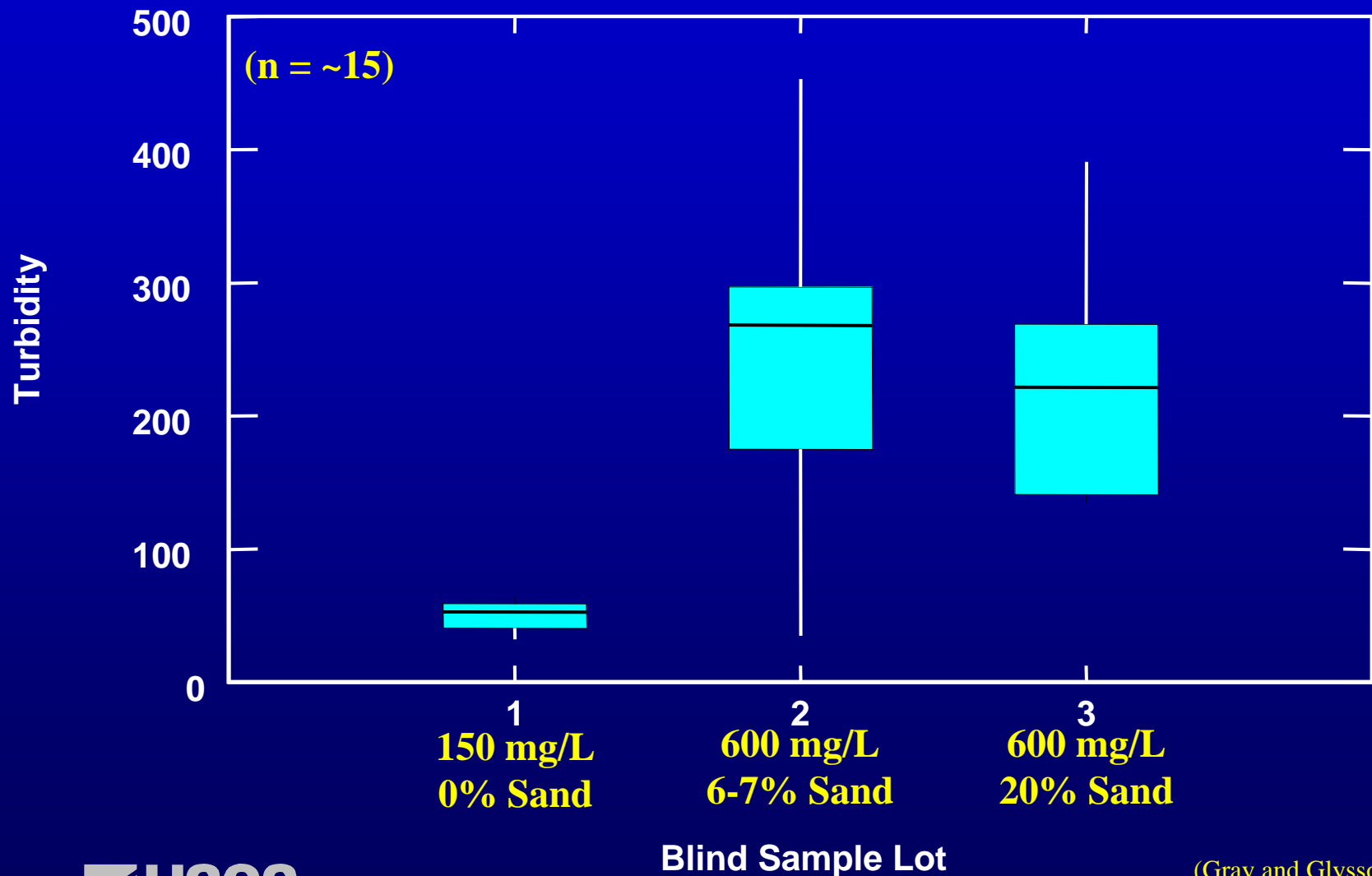
Consistency, Consistency, Consistency!

**USGS & ASTM will report and store data with
new reporting units based on instrument
type (Oct. 1, 2004)**

Outline

1. Problem / Definition
2. Measurement & Technology
3. Comparisons among instruments
4. USGS & ASTM response
 - Reporting Units
 - Data Storage

Problem: Large differences among instruments and users



(Gray and Glysson, 2002)

Definition of Turbidity

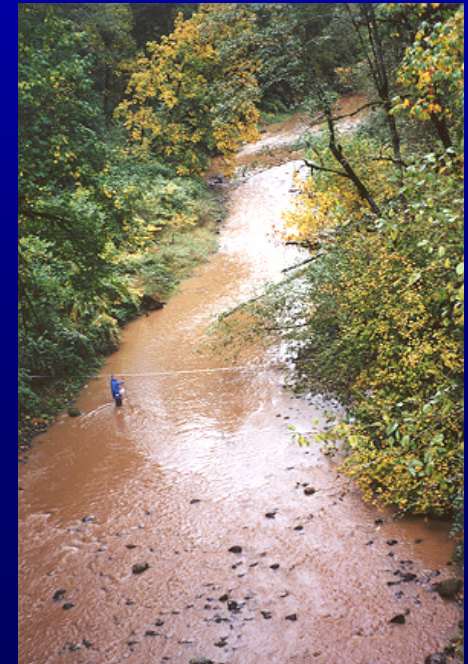
“...an expression of the optical properties of a liquid that causes light rays to be scattered and absorbed rather than transmitted in straight lines through a sample.” (ASTM International, 2003a)

- Suspended material

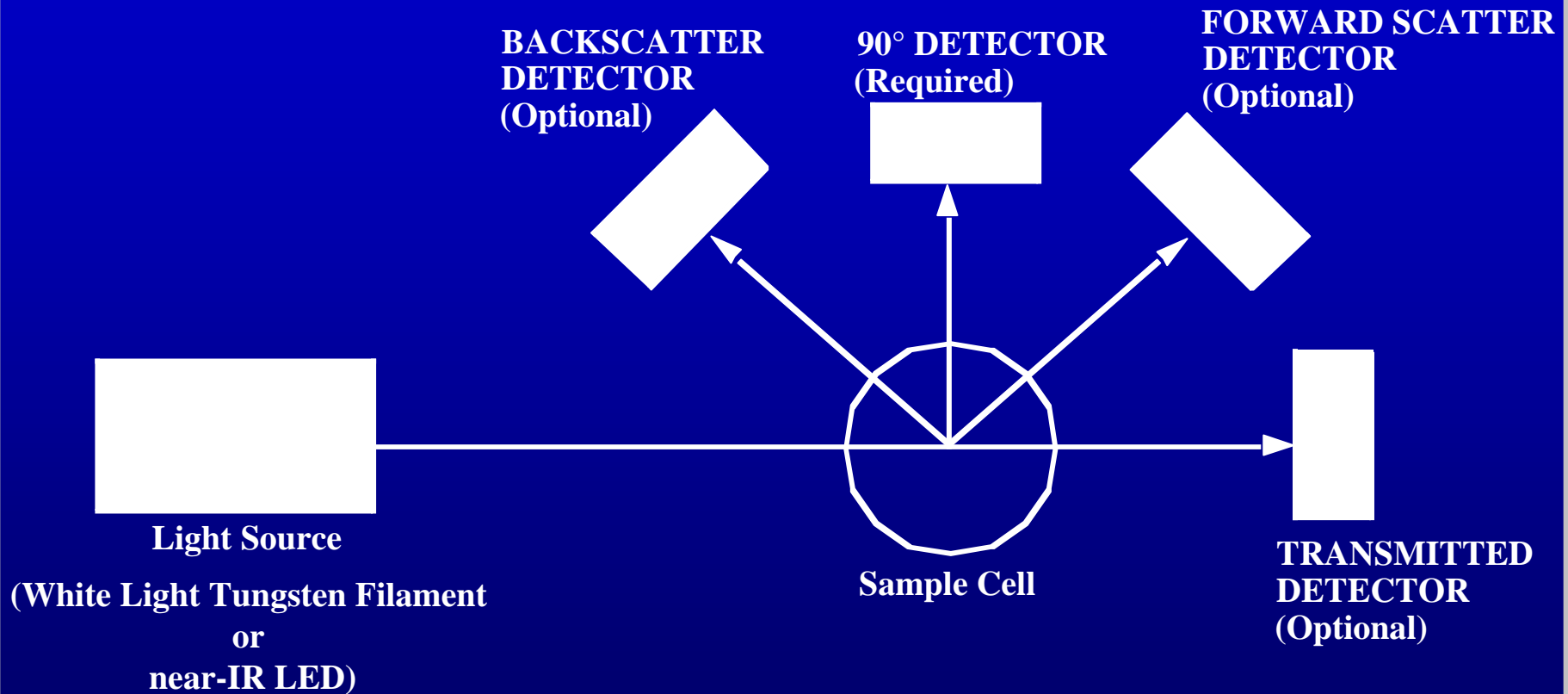
- clay, silt, finely divided organic matter, plankton, other microscopic organisms

- Dissolved material

- organic acids and dyes



Measurement

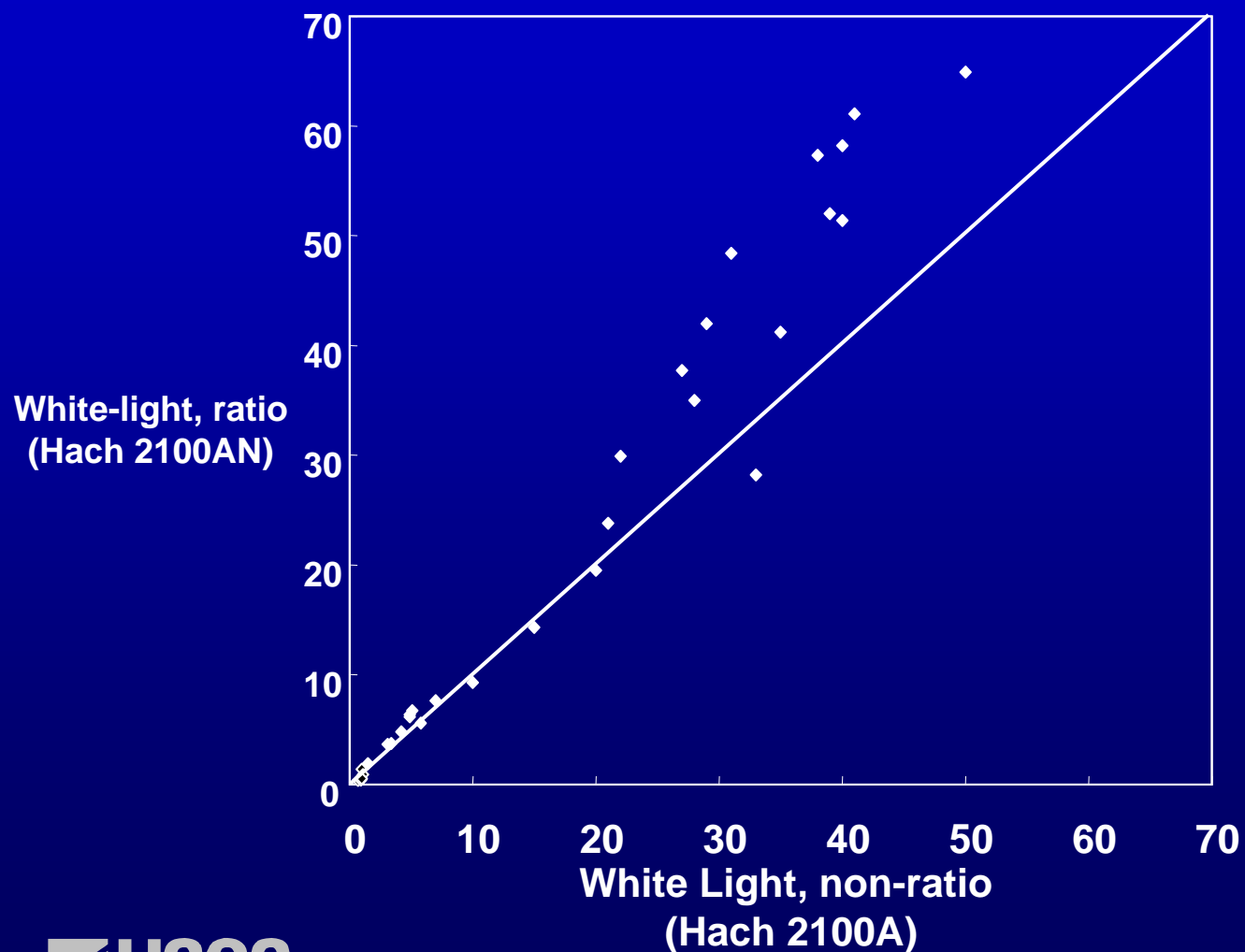


Technology

- Single detector, white light (standard nephelometry)
- Multiple detectors (ratiometry)
- Near-IR nephelometry
 - Non-ratio (single detector)
 - Ratio (multiple detectors)
- Surface Scatter
- Backscatter
- Attenuation / Transmission
- Static (benchtop) vs Dynamic (submersible)

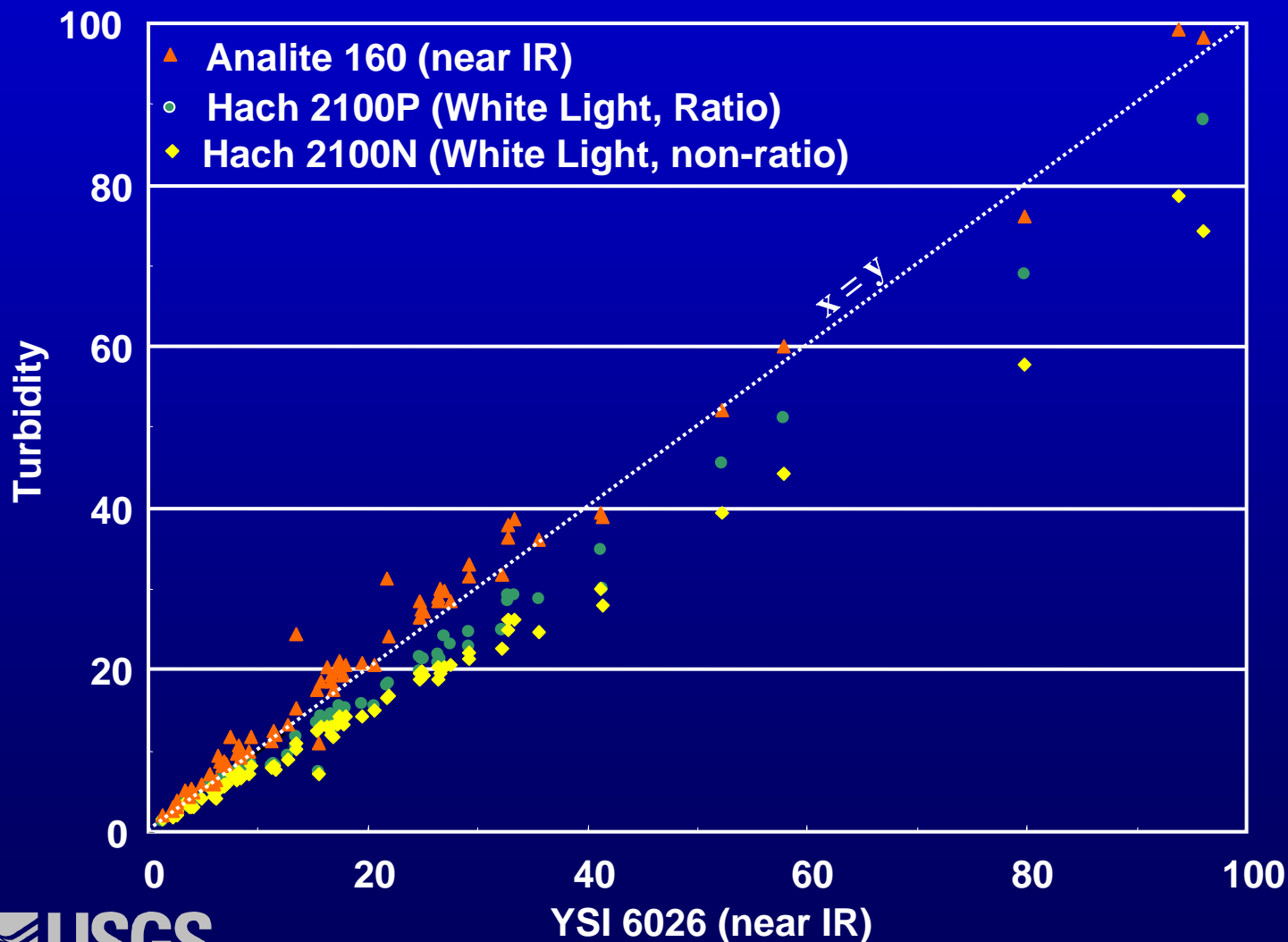


Effect of Color



Data from Pavelich, NWQL

Effect of Light Source & Detectors



New Reporting Units

Detector Geometry	Light Wavelength	
	White or broad band (400-680 nm)	Near-IR or Monochrome (780-900 nm)
Single-Beam Light Source		
Single Detector Nephelometry (90°)	NTU — Nephelometric Turbidity Unit	FNU — Formazin Nephelometric Unit
Multiple Detector Nephelometry (90° and other angles)	NTRU — Nephelometric Turbidity Ratio Unit	FNRU — Formazin Nephelometric Ratio Unit
Single Detector Backscatter (30°)	BU — Backscatter Unit	FBU — Formazin Backscatter Unit
Single Detector Attenuation (180°)	AU — Attenuation Unit	FAU — Formazin Attenuation Unit)
Multiple-Beam Light Source		
Multiple Detector Nephelometry (90° and other angles)	NTMU — Nephelometric Turbidity Multibeam Unit	FNMU — Formazin Nephelometric Multibeam Unit

Remaining issues

- New instruments continually being developed
- Still have large variability within some categories
- Databases
- Education

Where to from here?

- USGS National Field Manual Ch. 6.7
(<http://water.usgs.gov/owq/FieldManual>)
- USGS historical data won't be migrated to new pcodes unless specific information on instrument is available.
- FAQ
- ASTM Round-Robin

Conclusions

**There is no such thing as
“The Correct Turbidity”!**

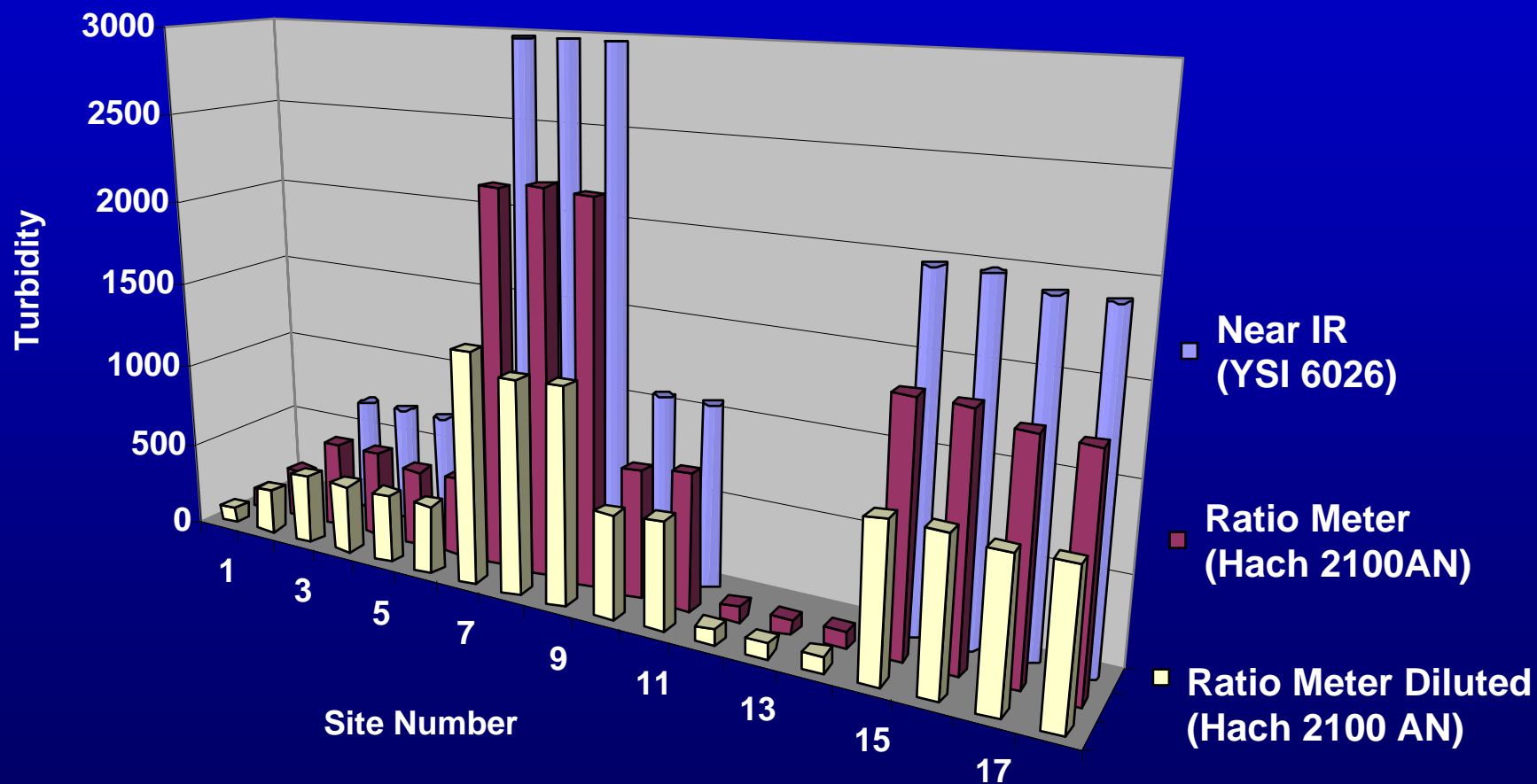
Consistency, Consistency, Consistency!

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with new reporting units based on
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Turbidity-- Considerations

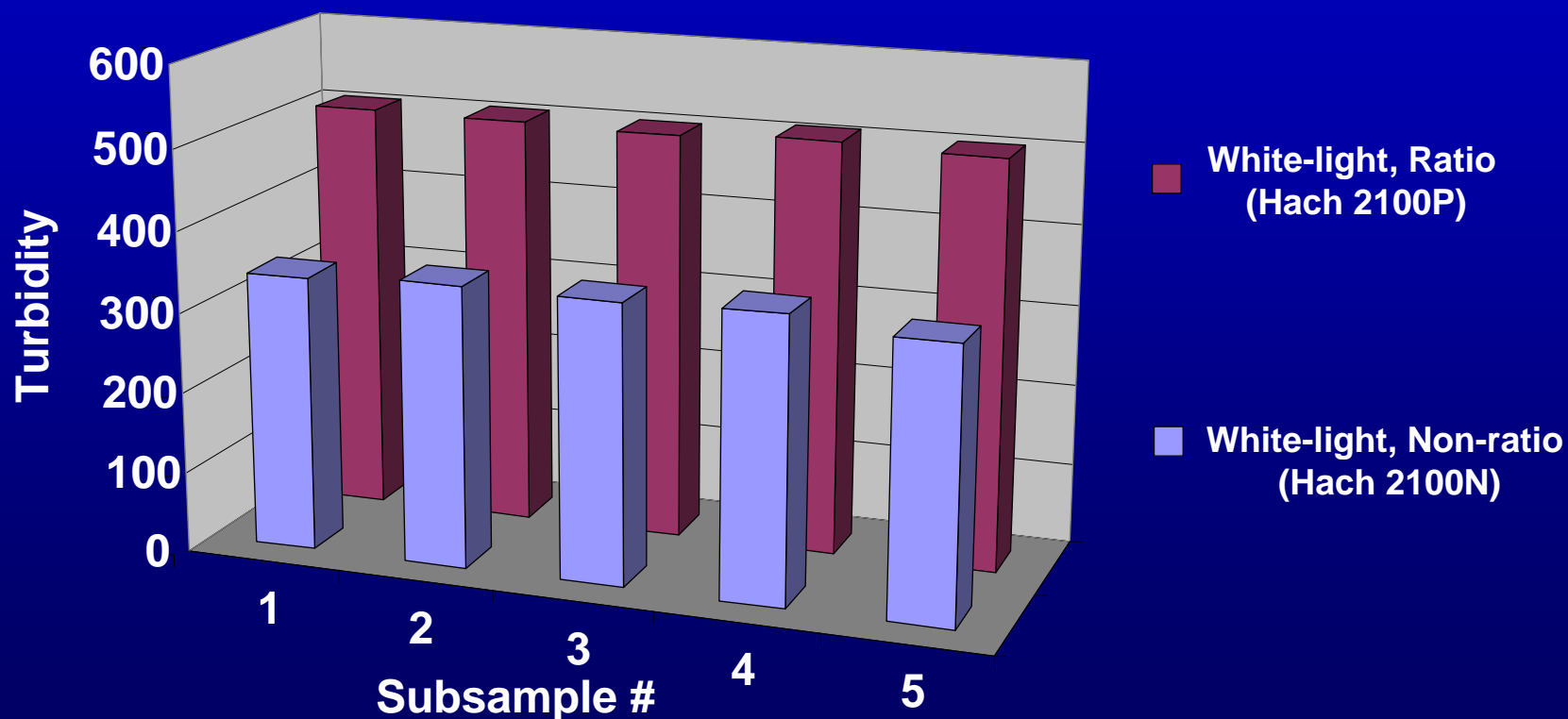
- Currently no federal regulations apply to natural waters
- Turbidity isn't an inherent physical property & is affected by many factors
- Technological advances that account for these factors also reduce comparability
- Techniques matter (static/dynamic, calibrants used)

Effect of Dilutions



Effect of Particle Size and Density

Upper Squaw Creek, 3-Sisters Wilderness, Oregon, August 2003



Factors affecting turbidity

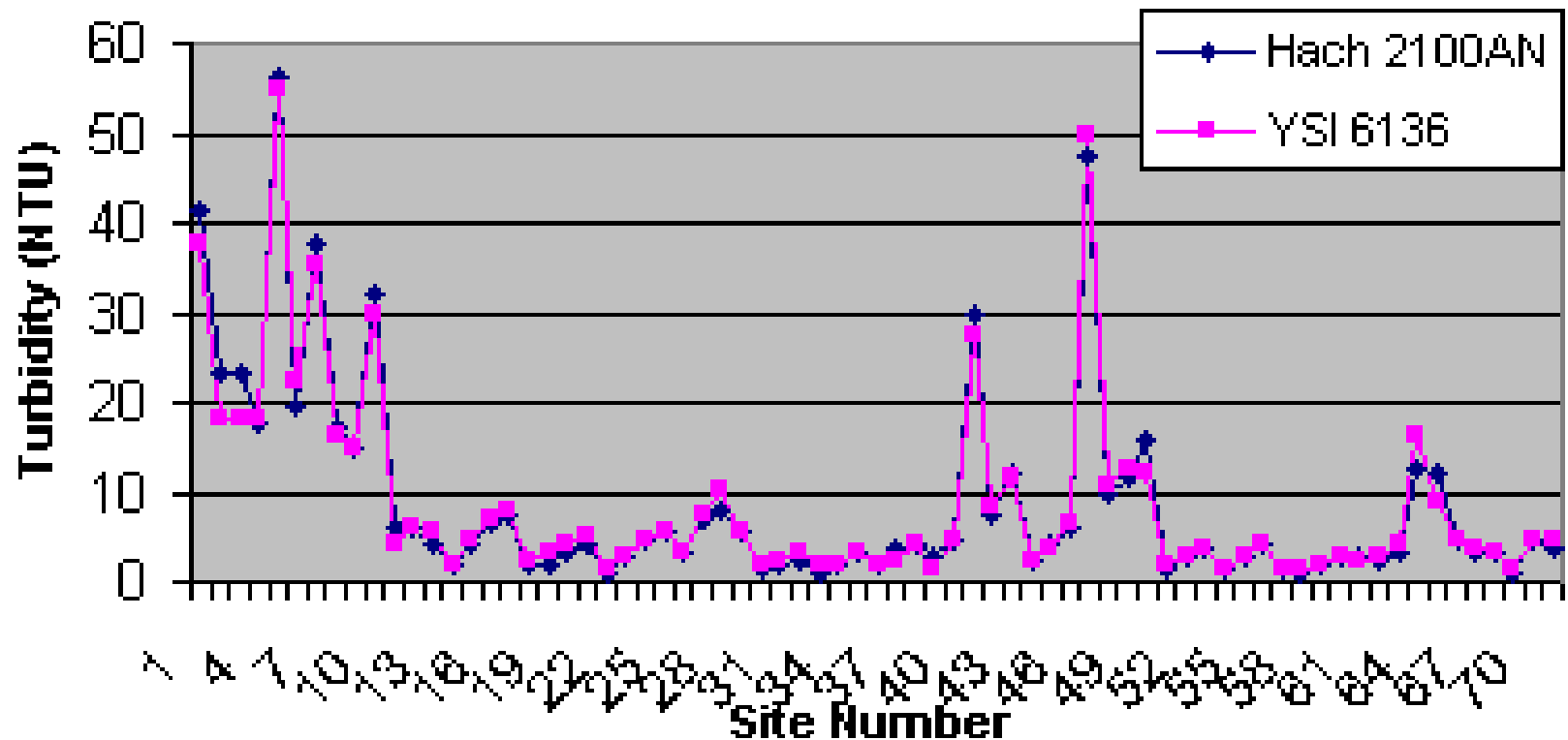
Properties of water matrix	Effect on Measurement	Direction of effect	Instrument designs to compensate
<u>Color</u>	Absorption of light beam	Negative (-)	<ul style="list-style-type: none"> •Near-IR •Multiple detectors
<u>Particle Size:</u> <ul style="list-style-type: none"> •Large •Small 	λ – Dependent	+ (Near IR) - (White)	<ul style="list-style-type: none"> •White Light •Near IR
<u>Particle Density</u>	Increases forward & back scattering	Negative (-)	<ul style="list-style-type: none"> •Multiple Detectors •Backscatter

Factors affecting measurements

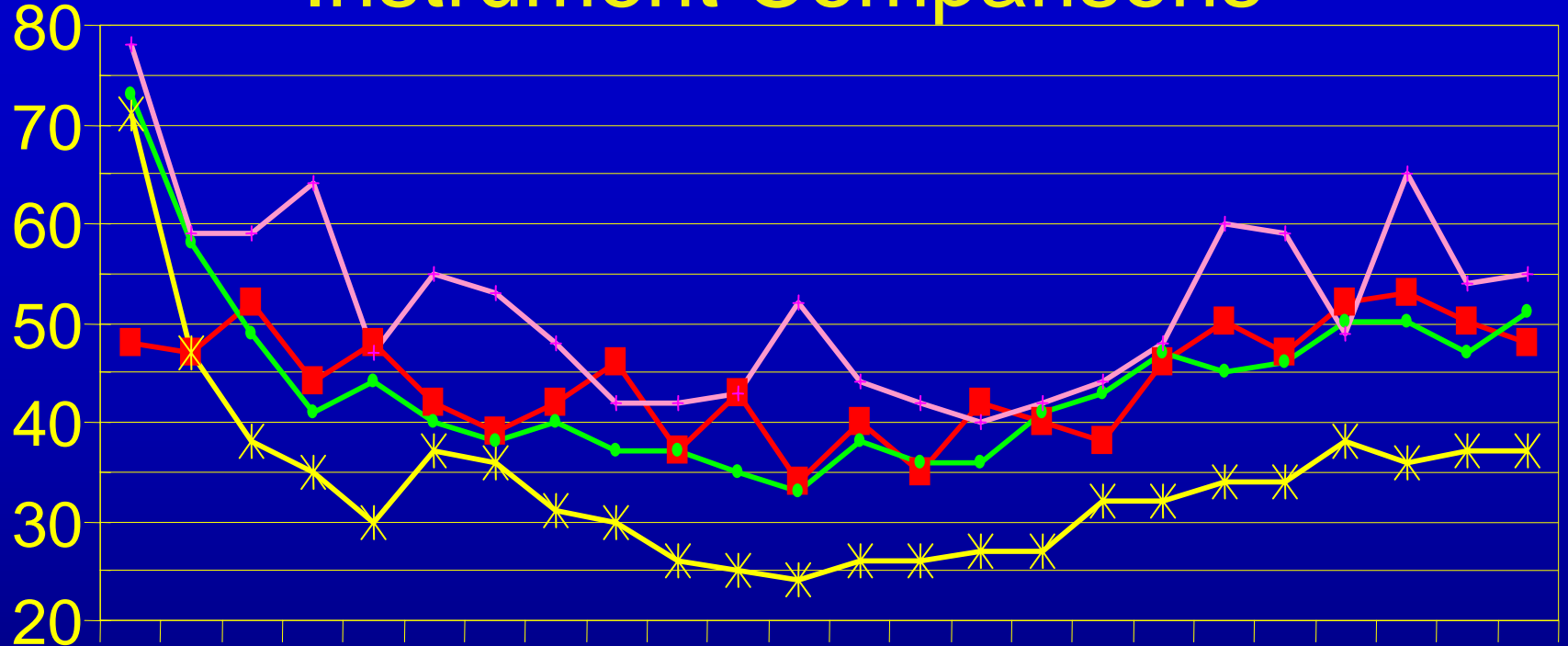
- Particles
- Color
- Light source
- Number and configuration of detectors
- Particle settling
- Mechanical & Sample problems

Example - YSI Probes

Comparison of new YSI turbidity probe with Hach
2100AN
Sites number 1-71



Instrument Comparisons



■ Near-IR, Dynamic

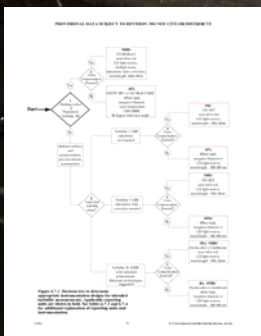
+ Near IR, Static

* White Light, Ratio (static)

● White Light (Static)

Which Instrument Do I Use?

- Based on Study Objectives
- Decision Tree to help users decide which instrument type to use



Data Storage

- USGS Database
 - New parameter codes for turbidity
 - Historical data will not be migrated without specific knowledge of instruments used
 - New method codes to designate each instrument (make, model, mode of op.)

Calibrants

- Reference Solution
 - Scratch Formazin (4000 TU)
- Calibration Solutions
 - Diluted scratch formazin or commercial standards
(StablCal™, AMCO AEPA-1™ polymers)
- Verification Standards
 - Solids, gels

FAQ

- EPA Role/Response?
- What about FTU?
- Polymer vs Formazin?
- Why do some units contain “formazin” in name and some don’t?
- Can USGS just do this w/o EPA?
- What’s the best instrument to use?